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Thursday, February 22, 2007

Partially self-replicating machines being built

There are some fascinating projects out there to build 3D printers that can manufacture a substantial amount of their own parts -- they are partially self-replicating. Self-replication in itself is largely of theoretical interest, as the reproduction process is very slow and labor intensive. Worse, the resulting machines can build devices only at the lowest common denominator of materials that can be easily 3D printed at room temperature. For any given kind of part, such general-purpose machines will be easily beaten in both production rate and quality of parts made by specialized machines.

Nevertheless, I find these devices quite interesting from a theoretical point of view. The complexity of design needed to make these machines fully self-replicating may give us some idea of how improbable it was for self-replicating life to originate.

In a hypothetical scenario where one lacked ready access to industrial civilization -- after a nuclear war or in a future space industry, for example -- machines like these could be quite useful for bootstrapping industry with a bare minimum of capital equipment. For similar reasons, it's possible that machines like these might prove useful in some developing world areas -- and indeed that seems to be a big goal of these projects. Add in open source code made in the first world but freely available in the third, and this opens up the intriguing possibility of a large catalog of parts that can be freely downloaded and cheaply printed. Also useful for this goal is to reduce the cost of the remaining parts not replicated by the machine -- although even, for example, $100 worth of parts is more than a year's income for many people in the developing world, and the polymer materials that can be most usefully printed are also rather expensive. But ya gotta start somewhere.

RepRap is a project to build a 3D printer that can manufacture all of its expensive parts. Although they call this "self-replicating", it might be better to think of their goal as an open-source digital smithy using plastics instead of iron. To achieve their goal the machine need not produce "widely-available [and inexpensive] bought-in parts (screws, washers, microelectronic chips, and the odd electric motor)." That's quite a shortcut as such parts, despite being cheap in first world terms, require a very widespread and complex infrastructure to manufacture and are rather costly by developing country standards. The machine also does not attempt to assemble itself -- extensive manual assembly is presumed. RepRap makes a practical intermediate goal between today's 3D printers and more complete forms of self-replication that would, for example, include all parts of substantial weight, would self-assemble, or both. The project is associated with some silly economics, but I'm hardly complaining as long as the bad ideas result in such good projects. So far RepRap has succeeded in producing "a complete set of parts for the screw section of the extruder."

Similar to RepRap, but apparently not quite as far along, is Tommelise. Their goal is that a craftsman can build a new Tommelise using an old Tommelise and $100-$150 in parts plus the cost of some extra tools.

About Me

Nick Szabo

"A premier thinker about history, law and economics, and the lessons they have for security." -- Adam Shostack, Emergent Chaos

"Szabo comes out with these essays that leave me in awe." -- Brian Dunbar

"Reading material that is eclectic, challenging and endlessly fascinating." -- Sean McGrath, Propylon

"Like most blogs worth my attention, this blog is updated only infrequently. That is because the authors of blogs worth my attention only post when they have something to say that is true, relevant and not already known by their audience. Most of the human race does not have the skill to know when an idea has these three properties. The skill is particularly rare in the fields of politics and economics, which is why this blog is such a rare and valuable thing." -- Richard Hollerith

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A less ambitious project that already works -- an open source fab, but with no goal of making its own parts -- is the Fab@Home project. Using Fab@Home folks have already printed out stuff in silicone, cake icing, chocolate, and more.

Meanwhile, in an economically attractive (but not self-replicating) application these guys want to print out bespoke bones based on CT or MRI scans.

Posted by Nick Szabo at 11:54 AM

7 comments:

Henry said...

Nice post on interesting technologies. I want one of those fabs.

The link to the article on the origin of life a etext is broken. I was able to find it in goolge's cache.

10:21 AM

Nick Szabo said...

Thanks!

3:40 PM

eddie said...

Self-replication is cool, but probably not useful. The point to a fab lab is rapid development of prototypes, not manufacturing. You use a fab lab to make unusual objects in small quantities on demand at high cost per object. You use "normal" manufacturing processes to make large quantities of standardized objects in bulk at low cost per object.

If a fab lab "for the masses" is useful, then it will be most usefully made by manufacturing processes, not by other fab labs. It will be made in larger quantities, at lower cost, with better components, and with greater capabilities than a fab lab made by a fab lab.

Self-replication is trying to solve the problem of "we have a fab lab, a computer, a decent supply of fusible materials such as plastic and metal, some power tools like drills and routers and soldering irons, some resistors, transistors, capacitors, diodes, and leds, some stepper motors, and some microchips... but we really wish we had a second fab lab." In what circumstances are you ever going to have all of that and *not* have ready access to someone who will sell you another fab lab?

3:28 PM

Chris said...

Part of the point of RepRap, as I understand it, is that the design can evolve. You can tweak the blueprints and use a RepRap to build, not just *another* RepRap, but *a better* RepRap. That's something you can't do with mass manufacturing.

Chris

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9:34 AM

Anonymous said...

Another problem is the child parts will never be as accurate as the parent part by printing alone. For example, you can scrape a plate flat by identifying the high points with dye pressed against a test plate. However if you don't know if the test plate is flat, it may be concave or convex and could also make the new plate curved. One way to counter this is to compare three plates with each other, but a twisted plate could match all three plates. Then you have to turn each plate 90 degrees when comparing to the other plates. These sort of things will also come up when you make a gear and then use that gear to make more gears.

5:09 PM

frapter said...

Indicating that self-replicators don't exist is absurd. You can see one at Wikipedia's Self-replicating machine article here:

http://en.wikipedia.org/wiki/Self-replicating_machine#F-Units

A photo of a real world actual self-replicator is linked at the bottom of the article (not a silly "stacker" like Cornell's so-called "replicator of late)

Charles Michael Collins

6:34 PM

frapter said...

Annon wrote:

"Another problem is the child parts will never be as accurate as the parent part by printing alone."

This is incorrect. If you read my site on F-Units here:
http://www.geocities.com/charles_c_22191/temporarypreviewfile.html?1198336233656

You would understand that "discrete" constructs of mass structure effect perfect copies. one copy or trillions, all are perfect. A simple explanation is if you build an object out of individual "units" like blocks or tile and the design plan is sound to build them with these blocks in an instruction code. The copies are always the same.

Charles Michael Collins

2:06 PM

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